

Date: 1st October 2021
Our Ref No.: TJ/UT1/OUT-10

To,
Doosan Heavy Industries & Construction Co., Ltd.
Mr. Youngsoo Son– Project Manager
465 Gangnam-daero, Seocho-gu, Seoul, Korea (06611)

Contract Reference: Engineering, Procurement and Construction Contract between Nepal Water And Energy Development Company Private Limited (NWEDC) and Doosan Heavy Industries & Construction Co. Ltd for the Engineering, Procurement and Construction (EPC) for the 216 MW Hydropower Plant at Upper Trishuli -1, Nepal

Subject: Submission of Review Notes on Surrounding Rock Stability Calculation of Adit No. 3 and Excavation and Initial Support Drawings of Adit No. 3

References:

1. Document No.: UT1-C-150-CVL-DC-43002, Rev. B dated 20th September 2021
2. Drawing No.: UT1-C-150-CVL-DG-43004, Rev. C dated 20th September 2021

Dear Sir,

Reference is made to the above No.1 and 2 including attachments, received with transmittal No. UT1-HEP-DHI-D-0052 dated 20th September 2021, regarding. surrounding rock stability calculation of adit no. 3 and excavation and initial support drawings of adit no. 3.

Please find our comments and replies in the Review Notes (RN-0014, RN-0015, RN-0016, and RN-0017) enclosed herewith this letter.

Sincerely,


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Mr. Carsten GUNTERMANN
Project Manager (CRE)



Enclosure:

1. Review Notes (RN-0014, RN-0015, RN-0016, and RN-0017)

UPPER TRISHULI-1 HEP (216MW)

Client Nepal Water and Energy Development Company Private Limited

Owner's Engineer Tractebel Engineering GmbH / Jade Consult

REVIEW NOTE

Contractor Doosan Heavy Industries & Construction Co., Ltd.

Title of the Document Surrounding Rock Stability Calculation of Adit No. 3

Document No. UT1-C-150-CVL-DC-43002 **Revision** B

Date of Documents 10.09.2021 **Received Date** 20.09.2021

Transmittal Form No. UT1-HEP-DHI-D-0052

Previous Review Date/Status 16.08.2021/RR **Prev. Review Note No.** RN-0006

Review Note No. **RN-0014** **Present Review Date** **30.09.2021**
Present Review Status **RR**

A: Approved AC: Approved with Comments RR: Returned for Resubmission

The report in hand is of the same structure and contains similar content as the report "Surrounding Rock Stability Calculation of Investigation Tunnel for the Powerhouse", document No. UT1-C-385-CVL-DC-65001. The designer is requested to incorporate the comments already made in the respective Review Note 0009, dated 20.09.2021, which refer to the general technical approach required for such report. Furthermore, the designer is requested to use the rock parameters, which we have listed in our Review Note regarding the "Statement of surrounding Rock Parameters of Adit No. 3". These are:

Upper Trishuli 1 HEP; Estimation of Rock Mass Strength and Deformation Properties for Tunnel Design

Rock Class	Q-value	Unit Weight 1)	Modulus of Deformation 2)	Poisson's Ratio	Cohesion 3)	Friction Angle 3)	UCS rm 4)	Dilation Angle 5)
	[-]	[kN/m ³]	[GPa]	[-]	[MPa]	[°]	[MPa]	[°]
I	>40	2.70	26.8	0.20	5.00	50	27.5	17
II	10 to 40	2.70	20.5	0.25	2.50	45	12.1	15
III	4 to 10	2.65	8.6	0.25	1.00	37	4.0	12
IV	1 to 4	2.60	2.3	0.30	0.50	30	1.7	10
V	<1	2.40	0.9	0.35	0.20	25	0.6	8

1) For determination of in-situ stresses the unit weight shall be taken as 2.65 kN/m³ for all rock classes.

2) The rock mass modulus of deformation was calculated using the equation of Hoek&Diederichs (2006) using GSI 10, 30, 50, 70 90, respectively and assuming D=0, MR = 400, $\sigma_{ci} = 70$ MPa.

3) Residual strength parameters shall be reduced by 1/2 for the cohesion and 20% for the friction angle.

4) UCSrm, "uniaxial strength of rock mass" was calculated using the Mohr-Coulomb-Criterion.

5) Dilation angle was estimated as 1/3 of the friction angle.

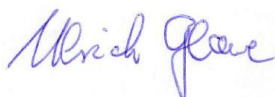
Presented parameters do not account for individual structural defects such as foliation or local shears.

The overburden thickness shall be taken as the maximum overburden thickness expected for the whole tunnel. In this case is the maximum overburden thickness 300 m as stated in the report. This overburden thickness shall be used for all rock classes as all rock classes may prevail in the tunnel, particularly far away from the portal, where the occurrence of shear zones or other weak zones cannot be excluded.

DISCLAIMER

Any approval will not release the Contractor from any of his obligations under the Contract.

Dr. Ulrich Glawe



(Signature)